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EnviroNET: An Interactive Space-Environment Information Resource

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EnviroNET is an interactive menu-driven system set up as an information resource for experimenters, program managers, and design and test engineers who are involved in space missions. Its basic use is as a fundamental single-source of data for the environment encountered by Shuttle and Space Station payloads, but it also has wider applicability in that it includes information on environments encountered by other satellites in both low altitude and high altitude (including geosynchronous) orbits. It incorporates both a text-retrieval mode and an interactive modeling code mode. The system is maintained on the ENVNET MicroVAX computer at NASA/Goddard Space Flight Center. Its services are available at no cost to any user who has access to a terminal and a dial-up port. It is a tail-node on SPAN, and so it is accessible either directly or through BITNET, ARPANET, and GTE/TELENET via NPSS.

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PREFACE

We wish to thank D. Bilitra, J. Green, A. Hedin, and J. Vette of NASA' Goddard Space Flight Center and N. Thomson of the University of Chicago for the various modeling codes used in EnviroNET. Funding was provided by NASA Headquarters, the AFGL Space Systems Environmental Interactions Technology Office, and by the U.S. Air Force Systems Command's Space Divisicn under Contract No. F04701-85-C-0086-P00019.

INTRODUCTION

The extensive use of space for platforms for communications, surveillance such as weather and earth resources, science research, military objectives, and manned activities is continuing to increase. With this increase comes an equivalent increase in the number of personnel who have to have knowledge about or access to information about the space environment and the local environment encountered on space platforms such as Shuttle or Space Station. Initially, many of these individuals do not have the appropriate technical background to be familiar with sources for the space environment data they require. There is also a need for a focal point of such information so that groups working on the same mission at different institutions have a common data base for use in their respective portions of the mission. Additionally, the common source should be easily modified and maintained with the most recent data available. EnviroNET has been created to perform this role.

DESCRIPTION

EnviroNET is an information resource for experimenters, design and test engineers, and program managers who are involved with space missions. Its basic use is as a fundamental single repository of information about the environmental areas of concern encountered by Shuttle and Space Station payloads, but it also has wider applicability for information on the somewhat hostile space environments encountered by satellites in both low altitude and high (including geosynchronous) orbits. It is maintained by NASA through cooperative efforts of industry, other government agencies, academia, and the NASA community.

EnviroNET incorporates a combination of expository text and numerical tables amounting to about one million characters (bytes) plus FORTRAN programs that model the neutral atmosphere, ionosphere, geomagnetic field, and the energetic electron and proton environments. This text is under continuous review, correction, and augmentation by ten subpanels of technical experts --

one for each of the main topics dealt with. The aim is to keep it as accurate and current as possible. The EnviroNET files are stored on a MicroVAX II computer at Goddard Space Flight Center and may be accessed on a 24-hour dial-up basis at 300/1200 baud with ordinary telephone connections and at 9600 baud for users on the Space Physics Analysis Network (SPAN). The SPAN network includes several hundred computers in the U.S. and in other countries.

EnviroNET is ideally suited for the science users who find it desirable and feasible to perform an increasing amount of their work by computer networking with their colleagues from their "remote" home laboratories and computers. This is an expansion of the concept started with the Atmosphere Explorer and Dynamics Explorer programs wherein remote scientists were connected over dedicated phone lines to a central "remote" computer site containing their data and computer programs. With the advent of SPAN, the remote Dynamics Explorer scientists could communicate with one another directly and offload calculations and data analysis to their home systems, thereby improving productivity with simultaneous analysis on remote, distributed computer systems. Following this example, we are creating a facility to permit the user to conduct teleanalysis, i.e., perform analysis of the Space Shuttle/Space Station environment data and use the space environment models on computers at remote institutions. This effort will include the NASA centers, other government laboratories, industry, and universities.

The academic community is also involved because it provides important opportunities for testing and evaluating new ideas, techniques and concepts before they have reached the state of maturity considered by contractors and project managers as being suitable for implementation. This testbed program provides a valuable way of training the graduate students who represent the future scientists and engineers of the nation, and who need to be at the leading edge of our developing technology to ensure our economic survival.

The various facilities in EnviroNET are accessed by a menu-driven system which includes a number of options: Retrieval and reading or downloading of text; summaries and/or plots of environmental parameters; on-line computations of magnetic field parameters, particle fluxes, atmospheric constituents, etc. For more detailed studies, software can be downloaded to the user's computer for use at his/her facility.

When the system is accessed for information, the Table of Contents is displayed and the user is instructed to select a topic. When the user has finished his/her activities related to the selected topic, the user is returned to the Table of Contents for additional topic selections. The menu-driven system includes the following options:

- retrieval and reading or downloading of text;
- downloading of high-resolution graphics summaries and/or environmental parameters;
- on-line computations of magnetic field parameters;
- on-line computations of particle fluxes, atmospheric constituents, etc.

Data flow in the EnviroNET system is shown in Figure 1. Text, data, and environmental models reside in a number of files on the ENVNET computer. A number of modeling groups, including the Natural Environments group with which we are associated, are responsible for the text, data bases, models, and interactive computation programs. These modules are installed and maintained on the EnviroNET system by NASA personnel who work directly on the ENVNET computer.

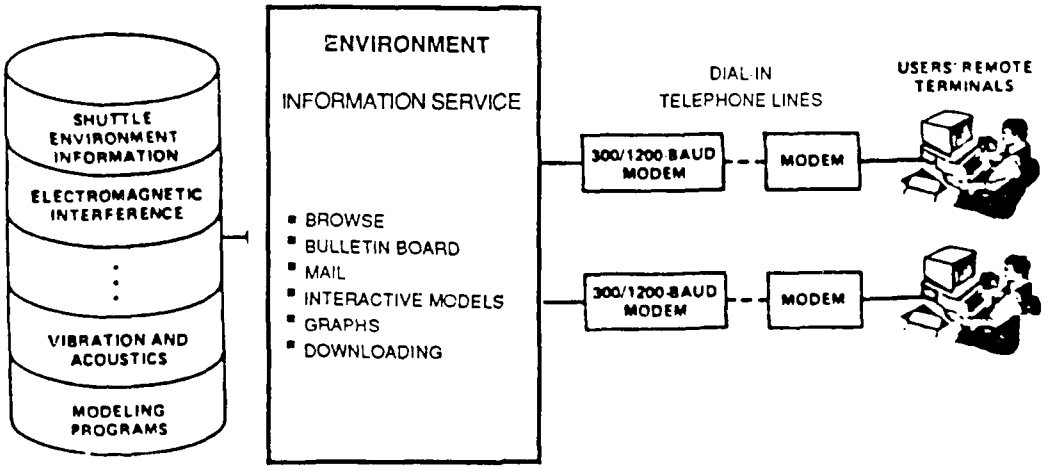

Figure 1. Data Flow in EnviroNET

USER ACCESS

User access to EnviroNET is shown in Figure 2. EnviroNET is a tail node on SPAN. Thus anyone who has access to SPAN either directly or through BITNET or ARPANET can access EnviroNET simply (e.g., using the SET HOST feature). Those who do not have access to SPAN directly can get access through the local GTE/TELENET system. To do this, they must obtain the GTE/TELENET local phone access number and enter through NPSS. Details for this access are available from NASA/Goddard. No charge is made for accessing and using EnviroNET, but users should avoid overloading or otherwise abusing the system. Rather than reading through many pages of text on-line, the text should be down-loaded to the user's local system and accessed there.

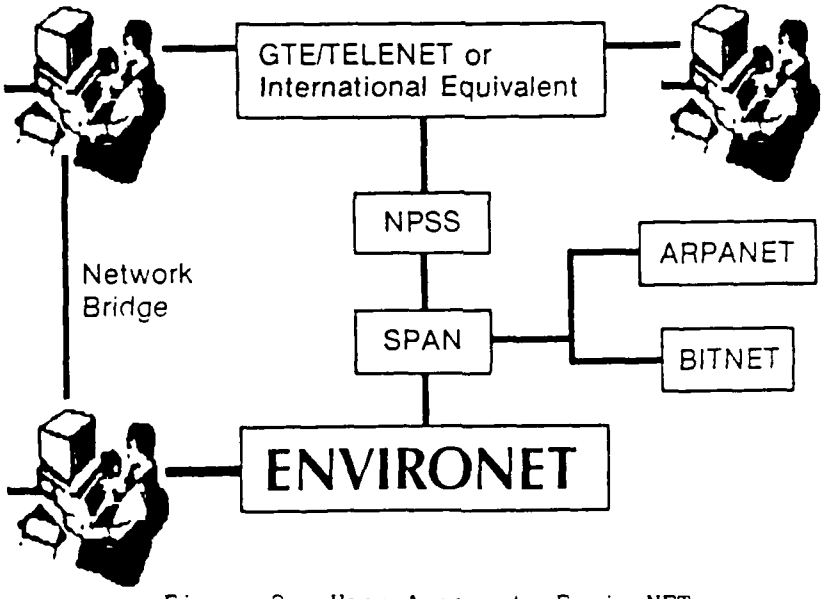

Figure 2. User Access to EnviroNET

BROWSE

For an introduction to the system (or for very short inquiries), the BROWSE system is available. The BROWSE system is menu-driven and permits fast, easy access to specific information in the system. It permits a number of activities:

- display of main topic headings;
- display of index of key-words and topics with chapter and page numbers;
- direct access to any specified page, plus forward and backward paging through text;
- search of indexed key-words or phrases;
- search of any character string in text.

For more detailed studies, text and software files can be downloaded to the user's computer for use at his/her facility.

DOWNLOADING TEXT AND FIGURES

Text may be downloaded by a number of options: KERMIT; direct copy to the screen with capture software at the user's end; or, by using the DEC file transfer protocols available on SPAN. Note that if the text is downloaded by copying it to the screen, it is up to the user to capture it on the local computer as it is displayed. The DEC file transfer method is much faster and can be done in batch mode, provided your terminal has access to SPAN. The chapters which may be downloaded as text are the following:

Thermal and Humidity

Vibration and Acoustics

Electromagnetic Interference

Loads and Low Frequency Dynamics

Microbial and Toxic Contaminants

Molecular Contamination

Natural Environment

Orbiter Motion

Particulate Environment

Surface Interactions

Definitions and Acronyms

The technical content of the information is constantly improved to keep it current. After flight data have been extracted, analyzed, and verified by other scientists, the information is entered into EnviroNET. The inclusion of models makes EnviroNET an interactive system instead of just an archive of information. Panels are contributing new information on a continuing basis. They are also trying to work with principal investigators on extraction of flight data from experiments and are participating in technical meetings and workshops.

Data graphs and figures can be downloaded as bitmaps from EnviroNET for viewing on a user's terminal if a color board and a color monitor are available. The KERMIT protocol is used. First, the graphics software is downloaded; then the figure is selected and may be downloaded either using KERMIT or by a direct copy to the user's terminal using the DEC file transfer protocols.

INTERACTIVE SOFTWARE AND MODELS

The current interactive computation software includes a magnetic field tracing routine, several energetic particle models, MSIS-86, and the International Reference Ionosphere. The models are accessed by entering the Function Calculation System selected from the main menu. When this system is selected, a new menu is displayed from which one can select the MSIS-86 Neutral Thermosphere Model, the International Reference Ionosphere, the Magnetic Field Model, or Energetic Particles Models. A brief description of each of these follows.

The MSIS-86 Neutral Thermosphere Model is the 1986 COSPAR International Reference Atmosphere and is based on in-situ composition and temperature measurements and ground-based radar measurements covering a complete solar cycle. The inputs required, which are prompted for, are: day, altitude, latitude, longitude, local time, $F_{10.7}$ flux (both 3-month and previous day averages), and the magnetic index A_p. The model, which is valid over the altitude range of 85 km to 1000 km, produces the following outputs: number densities of H, N, He, N_2, O_2, and Ar in cm^{-3}, total mass density in gm/cm^3, and exospheric temperature and the temperature at the selected altitude, both in ^oK.

The International Reference Ionosphere Model (IRI-86) provides the ionospheric density and temperature, electron density profiles, electron and ion temperatures, ion composition (O^+, H^+, He^+, O_2^+, and NO^+) and a 12-month running mean sunspot number. Again, temperatures are in ^oK and compositions are in cm^{-3}. The model prompts for geographic latitude, longitude, altitude, month, local time, and solar activity (quiet, moderate, or active).

The Magnetic Field Model used is a much-modified version of a code originally written by G. Mead. For the internal field, the model permits the user to select a dipole field or any of the standard internal field coefficient sets: the Definitive Geomagnetic Reference Fields (DGRF) for 1965, 1970, 1975, and 1980 and the International Geomagnetic Reference Field 1985. The user may opt against using an external contribution to the field or may select a number of options: Mead-Fairfield Quiet, M-F Disturbed, M-F Super Quiet, M-F Super Disturbed, Olson-Pfitzer No Tilt, or O-P Tilted. Calculations may be performed either at a point or along a field trace. The program prompts for the type of trace (up, down, north, or south), type of field model(s), the epoch, and the latitude, longitude, and altitude for the start of the trace or for the point. The output is the latitude, longitude, altitude and total field at the point or at various points along the trace. Three orthogonal components of the field (outward, south, and east) are also returned at each point. If a trace is requested, the equatorial value of B and McIlwain's parameter L are also provided if the equatorial region is crossed during the trace.

The Energetic Electron Models that are currently (November 1987) in EnviroNET are the AE6 electron model for the region $1.4 \leq L \leq 2.2$ and AE7-Hi for $2.2 \leq L \leq 8.25$. AE7-Hi consists of a number of two-component exponentials defined at the equator for a number of L intervals. They are terminated at 7.5 MeV. The model calculation uses logarithmic interpolation in E and L and a $\sin^2\lambda$ interpolation along the field line. The proton model used is AP6 for the intervals $1.2 \leq L \leq 6.0$ and $0.1 \leq E \leq 170$ MeV. Tabular interpolation at the equator and along a field line are similar to those used in the electron calculation. Both unidirectional differential and integral flux are returned for the electrons. Only omnidirectional integral fluxes are returned for the protons. Values returned by these subroutines are within a factor of 2 to 3 of the values which AP8 and AE8 would predict. This accuracy is within the

confidence limits of AP8 and AE8, and so can be used without reservation until the more comprehensive models are available.

FUTURE PLANS

Future plans include adding the following to EnviroNET: downloading of all codes and models; incorporation of the AE8 electron and AP8 proton models; orbital integrations of fluxes; addition of the ORB and ORP codes from NSSDC. The orbital integrations will have limited orbital position and energy resolution in order to avoid having users overload the system by attempting to do detailed calculations. The intent will be that a user will be able to determine whether the energetic particle environment might be a problem or not. If it might be, the user then can download the appropriate codes and models and do more detailed calculations at his/her own facility.

More distant plans include the addition of dose calculations as a function of shielding and position in orbit and calculation of cosmic ray fluxes as a function of mass, energy, and position in orbit.